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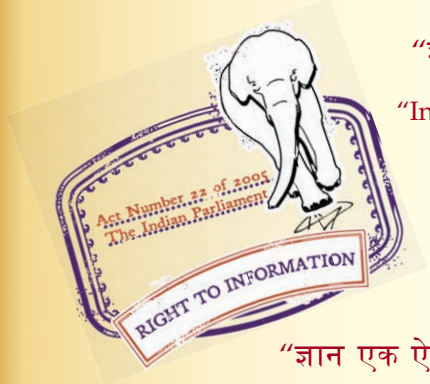
IS 12045 (1987): Alloys used in electrical resistance metallic heating elements [MTD 16: Alloy Steels and Forgings]



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"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 12045 - 1987
(Reaffirmed 1997)

Indian Standard

SPECIFICATION FOR ALLOYS USED IN ELECTRICAL RESISTANCE METALLIC HEATING ELEMENTS

UDC 669·018·57 : 621·365·41·036·66

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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October 1987

Indian Standard

SPECIFICATION FOR ALLOYS USED IN ELECTRICAL RESISTANCE METALLIC HEATING ELEMENTS

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Indian Standard

SPECIFICATION FOR ALLOYS USED IN ELECTRICAL RESISTANCE METALLIC HEATING ELEMENTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 22 April 1987, after the draft finalized by the Special Alloys Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Electrical resistance heating alloys are widely used for manufacturing incandescent heaters, resistors, rheostats, shunts, as well as heating elements for furnaces. There are various types of alloys available and this standard specifies the chemical composition as well as other characteristics which are essential for an alloy to be used for such applications.

0.3 This standard has been prepared to guide the manufacturers of electrical appliances to procure a suitable quality alloys in the form of wires, tapes and strips to be used as heating elements.

0.3.1 In the preparation of this standard, assistance has been derived from the following:

a) JIS C 2520 Electric heating wires and ribbons; and

b) ASTM B 344 Specification for drawn or rolled nickel chromium and nickel chromium iron alloys for electrical heating elements.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in the standard.

1. SCOPE

1.1 This standard specifies the requirements for nickel-chromium, nickel-chromium-iron and iron-chromium-aluminium alloys to be used as electrical resistance heating elements.

*Rules for rounding off numerical values (*revised*).

1.2 The characteristics of different types of alloys are given in Appendix A.

2. CHEMICAL COMPOSITION

2.1 The chemical composition of the various types of alloys shall be as given below:

Sl No.	*Alloy Type*	Ni	Cr	Al	C	Si	Nn	Fe
1.	80Ni-20Cr (Type 1)	77 *Min*	19-21	—	0·15 *Max*	0·75-1·5	2·5 *Max*	1 *Max*
2.	60Ni-15Cr-25Fe (Type 2)	57 *Min*	15-18	—	0·15 *Max*	0·75-1·5	1·5 *Max*	Remainder
3.	45Ni-23Cr-37Fe (Type 3)	45 *Min*	20-24	—	0·10 *Max*	1·5-2·5	1·3-1·7	Remainder
4.	35Ni-20Cr-45Fe (Type 4)	35 *Min*	18-20	—	0·15 *Max*	0·75-1·5	1·5 *Max*	Remainder
5.	32Ni-20Cr-48Fe (Type 5)	32 *Min*	20-21	—	0·05-0·09	1·5-2·00	1·0-1·4	Remainder
6.	Fe-25Cr-5Al (Type 6)	—	23-26	4-6	0·10 *Max*	1·5 *Max*	1·0 *Max*	Remainder
7.	Fe-19Cr-3Al (Type 7)	—	17-21	2-4	0·10 *Max*	1·5 *Max*	1·0 *Max*	Remainder

2.2 Sample for Chemical Analysis — For lot sizes greater than 500 kg, the sample for chemical analysis shall consist of clean drillings, millings or chippings from wire or strip selected for the purpose of the test. For smaller lot sizes, ladle analysis/analysis at billet stage shall be reported.

2.3 Chemical analysis may be carried out by any standard instrumental/chemical method.

3. MECHANICAL PROPERTIES

3.1 The mechanical properties for the different types of alloys are given below for guidance only.

Alloy Type	*Tensile Strength* MPa	*Hardness* HRB	*Percentage Elongation on Gauge Length of 50 mm*
Type 1	700	80-85	25-35
Type 2	650	80-85	25-35
Type 3	700	80-85	25-35
Type 4	500	80-85	20-30
Type 5	700	80-85	20-30
Type 6	700	160-180	15-20
Type 7	600	150-170	15-25

4. ELECTRICAL PROPERTIES

4.1 Resistivity — The volume resistivity in micro-ohm-cm at 20°C in annealed and rapidly cooled condition for different types of alloys shall be as given below:

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Resistivity, percent	108±6	112±6	112±6	100±6	104±6	142±7	123±6

4.1.1 Electrical resistivity shall be measured in accordance with IS : 3635-1966*.

4.2 Nominal Electrical Resistance — The nominal electrical resistance per unit length shall be calculated from the nominal resistivity and the nominal cross-sectional area.

4.13 Tolerance on Electrical Resistance per Unit Length — The actual resistance per unit length shall not vary from the nominal resistance by more than the amounts shown below:

Round Wire	*Tolerance, Percent*
0·13 mm and larger	± 5
Less than 0·13 and up to 0·05 mm	± 8
Finer than 0·05 mm dia	± 10
Ribbons and Strips	
Cold rolled	± 5
Hot rolled	± 8

4.4 Accelerated Life Test — Accelerated life test shall be carried out in accordance with IS : 3394-1985†.

NOTE — Sample mounting can also be carried out by any other method as agreed to between the contracting parties.

5. PHYSICAL CONDITION

5.1 The finished material shall be supplied in the fully annealed condition.

5.2 The material shall be uniform and free from surface defects, such as splits, kinks, laminations, scales and other irregularities. The finish shall be either bright annealed or oxidized, as agreed to between the contracting parties.

*Methods of test for resistance of metallic electrical resistance material.

†Method for accelerated life test of electrical resistance alloys for heating elements (*first revision*).

6. PACKING AND MARKING

6.1 Packing — The mode of packing the material for delivery shall be subject to agreement between the contracting parties.

6.2 Marking — Each package of material shall be marked with the following information:

a) Name or trade-mark of the manufacturer,

b) Type of the material,

c) Cast/melt number,

d) Product dimensions,

e) Date of manufacture, and

f) Net and gross weight.

6.2.1 The material may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

APPENDIX A

(Clause 1.2)

CHARACTERISTICS OF DIFFERENT TYPES OF ALLOYS

A-1. 80Ni-20Cr Alloy — This is probably the most widely used heating element alloy and is highly resistant to oxidation and corrosion up to a maximum temperature of 1 175°C. It is specially suitable for heat-treatment furnaces having reducing or oxidizing atmosphere, and may be used for incandescent heaters and semi-precision resistors.

A-2. 60Ni-15Cr-25Fe Alloy — The maximum operating temperature of this type of alloy is about 1 000°C, which is roughly 150°C less than that of the 80Ni-20Cr alloy. Low operating temperature and slightly inferior oxidation resistance, restrict the use of this material as heating element in electric furnaces. Its main applications are in low and medium duty electrical appliances, such as iron, toasters, coffee-maker, hair-driers, grills, etc.

A-3. 45Ni-23Cr-37Fe Alloy — This type of alloy is specially developed for use in controlled atmospheres furnaces particularly carburizing atmosphere, in the temperature range of 950-1 100°C. They are also used as 'cold' resistances and similarly in braking application for traction motors.

A-4. 35Ni-20Cr-45Fe Alloy — This type of alloy was specially developed as a low cost material suitable for operation at comparatively low temperatures. They are mainly used for controlled atmosphere furnace applications in the temperature range of 800-1 000°C, and may also be used for rheostats, shunts, etc.

A-5. 32Ni-20Cr-48Fe Alloys — This type of alloy is developed for use in controlled atmosphere furnaces below 1 100°C. It is highly resistant to sulphur attack and 'green rot'. It is also used in industrial rheostats where service temperature is relatively low.

A-6. Fe-Cr-Al Alloys — These types of alloys were developed in many countries as a substitute for nickel-chromium type of alloys. These alloys can be used for domestic as well as industrial applications at temperature up to 1 200°C.